

## POLICY PERSPECTIVE

# Conservation Traps and Long-Term Species Persistence in Human-Dominated Systems

Laura Cardador<sup>1</sup>, Lluís Brotons<sup>1,2</sup>, François Mougeot<sup>3</sup>, David Giral<sup>1</sup>, Gerard Bota<sup>1</sup>, Manel Pomarol<sup>4</sup>, & Beatriz Arroyo<sup>5</sup>

<sup>1</sup> Forest Sciences Center of Catalonia (CTFC), Crta. de Sant Llorenç de Morunys Km 2, 25280, Solsona, Catalonia, Spain

<sup>2</sup> CREAF, Edifici C, Autonomous University of Barcelona, 08193, Bellaterra, Catalonia, Spain

<sup>3</sup> Estación Experimental de Zonas Áridas (EEZA-CSIC), Carretera de Sacramento s/n, 04120, La Cañada de San Urbano, Almería, Spain

<sup>4</sup> Servei de Biodiversitat (Govern de Catalunya), Dr. Roux 80, 08017, Barcelona, Spain

<sup>5</sup> Instituto de Investigación en Recursos Cinegéticos (IREC)-(CSIC-UCLM-JCCM), Ronda de Toledo s/n, 13005, Ciudad Real, Spain

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### Correspondence

Laura Cardador, Department of Conservation Biology, Estación Biológica de Doñana (CSIC), C/ Americo Vespucio s/n, 41092 Sevilla, Spain. Tel: +34-973-48-17 52; fax: +34-973-48-1392. E-mail: lauracardador@ebd.csic.es /lcardador81@gmail.com

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### Abstract

Major conservation efforts in human-dominated systems, such as farmland, have focused on the establishment of subsidies and compensation promoting low-impact management practices to reverse the impacts of conservation threats in the short term (reactive approaches). In this study, we discuss how a different way of framing conservation policy (proactive approaches) could lead to fundamentally different long-term conservation outcomes. We define proactive approaches as those not necessarily including measures directly addressing the threats affecting biodiversity, but promoting transitions from current scenarios in which species are threatened to new states in which the threat is no longer present. We illustrate reactive and proactive approaches using as a case study two contrasting conservation frameworks for a vulnerable farmland bird, the Montagu's harrier (*Circus pygargus*) in northeastern Spain. This example shows that reactive approaches can lead to "conservation traps," which we defined as situations where the application of biologically focused actions in response to conservation problems results in an unsustainable need to perpetuate the implementation of those actions. Our aim is to offer a fresh perspective on biodiversity conservation in human-dominated systems and to stimulate alternative, more holistic approaches in conservation promoting transitions to new states not requiring long-term active and costly conservation action.

## Introduction

Human activities have caused large-scale transformations to ecosystems, with important impacts on biodiversity and the services these systems provide (MA 2005). In response to such transformations, large-scale conservation efforts have been deployed to develop strategies to halt and reverse current biodiversity loss trends. The cornerstone of these strategies has been founded in the implementation of a "preservation approach," based on the premise that biodiversity values can be maintained in protected areas with strict regulation of human activities (Margules & Pressey 2000; Bruner 2001).

However, high biodiversity is often concentrated in complex human-dominated, socioecological systems, such as extensive farmlands under pressure from agricultural intensification and land abandonment (Bouma *et al.* 1998; Henle *et al.* 2008). There is broad consensus that conservation strategies should reconcile the maintenance of biodiversity values with socioeconomic development in such systems. The successful implementation of such programs is proving, however, difficult to achieve (Firbank 2005; Henle *et al.* 2008).

In human-dominated landscapes, conservation management usually shifts from a preservation approach to reactive strategies targeted at halting the ecological

damage and ongoing impacts of human threats on biodiversity. This is commonly accomplished through the implementation of regulatory approaches or the promotion of particular management practices and human behaviors linked to financial incentives (Ferraro & Kiss 2002; Henle *et al.* 2008). Additionally, reactive conservation approaches often require active management aimed to increase biodiversity of targeted communities to a given level, or populations of targeted species back to a viable size. Typical approaches would include provision or management of habitats, predator, or disease control or translocations (Sutherland *et al.* 2004a, see also Appendix S1 for more specific examples of reactive approaches).

In many western European countries, reactive conservation approaches aimed at removing the negative effects of human influence on biodiversity and restoring populations to a minimum viable size have been implemented through the establishment of economic programs that redirect the labor of private landowners to low-impact, environmentally friendly management practices, mostly supported from an ecological point of view and for which markets offer no compensation. While this approach may be valuable in some cases, its economic viability and long-term efficacy for reversing the negative biodiversity and population trends of different biotic groups is actively debated (Kleijn & Sutherland 2003; Kleijn *et al.* 2009).

Conservation approaches based on active management or economic compensation may lead to an increase in conservation budget needs, potentially risking the longevity of their impacts. For example, the value of economic losses for which farmers are compensated, or the number of farmers compensated (e.g., for losses of yield productivity due to environmental-friendly management), may increase over time when populations of targeted species recover. Additionally, the application of such conservation measures may lead to the promotion of maladaptive phenotypes or behaviors (in the case of animals), leading in turn to the need for more active protection. For example, releases of captive-reared individuals to accelerate the recovery of their wild populations have resulted in cases in negative consequences through interference between wild and released individuals (Champagnon *et al.* 2012), thus increasing the need for new conservation actions. Provision of supplementary food to help food-limited animal populations may select for poor foragers, thus perpetuating the need to provide food or creating new conservation problems as other ecological parameters, such as dispersal behavior, recruitment, population sex-ratio, or survival are altered (Martínez-Abraín & Oro 2013). More importantly, since conservation-targeted payments do not necessarily modify the ultimate causes behind conservation threats, these strategies may need to be indefinitely maintained to have

a long-term impact (De Snoo *et al.* 2013). This is particularly relevant in human-dominated systems, such as agricultural landscapes, where reactive conservation approaches usually try to mimic the effect of past natural or human agents that are currently missing in the system or have been profoundly modified (Fischer *et al.* 2012). Therefore, if these financial incentives disappear, so may the management practices that are artificially maintained by those payments leading to communities or populations reverting to their initial state. Because these strategies may need to be continually implemented to be successful, they can consume the limited resources available for conservation for the targeted communities or species.

It is increasingly recognized that considering the economic costs of conservation to maximize the greatest return on investments can lead to substantially larger biological gains. However, in most cases, cost-effectiveness analyses mainly focus on how or where to best assign active management and financial payments to reach biological/recovery goals in the short-term (e.g., Sebastián-González *et al.* 2011). The capacity of these approaches for providing acceptable long-term solutions may thus be limited, since they overlook the fact that more sustainable solutions may be derived from management options that not only address current threats but also make durable changes likely (Firbank 2005; Fischer *et al.* 2012). Moving toward approximations that proactively seek solutions by confronting available global conservation strategies and their biodiversity benefits, as well as their socioeconomic feasibility in the long-term, may lead to novel approaches. We define proactive conservation approaches as those promoting transitions from current states in which biodiversity is threatened by a recognizable pressure, to new states in which the threat identified is no longer present. These measures could be deployed before the threat becomes a problem (Drechsler *et al.* 2011) or could target ongoing threats. Proactive approaches do not necessarily include measures directly addressing the threats affecting species persistence and thus biodiversity, and therefore may have, per se, low direct impacts on species survival or reproductive output in the short-term; however, if successful, they would have long-term positive impacts even after the conservation actions have stopped.

Here, we discuss how different ways of framing conservation policy (reactive vs. proactive approaches, defined according to their expected costs and effectiveness in the short- and long-term) can lead to different long-term outcomes. We then introduce the concept of “conservation trap” to describe situations where the application of reactive approaches based on biologically focused solutions results in the need to perpetuate its implementation and its associated costs. In these cases, biodiversity

**Table 1** Characterization of reactive and proactive conservation measures based on the different criteria included in the decision-making process for assessing the effectiveness of such strategies. Potential for a conservation trap if criteria 2, 3 and 4 are high

Criteria	Reactive	Proactive
(1) Their effectiveness in reversing trends of targeted communities or species, via short-term modifications of parameters like species richness, productivity or survival	High	Low/High
(2) The economic costs directly associated with their implementation	Low/High	Low/High
(3) The expected long-term need of maintaining that measure	High	Low
(4) The negative effects on species and communities if that measure is not maintained	High	Low

preservation or the viability of targeted species becomes largely dependent on the duration of conservation effort (and, indirectly, on monetary incentives). We illustrate conservation traps and strategies using an example that we know well, the conservation management of a vulnerable farmland bird, the Montagu's harrier (*Circus pygargus*) in northeastern Spain. However, similar situations and conservations challenges are likely to apply to many other species and communities in human-dominated systems. Our aim is to offer a fresh perspective on biodiversity conservation in farming landscapes, and to stimulate alternative, more holistic approaches in conservation.

## Conservation strategies and conservation traps

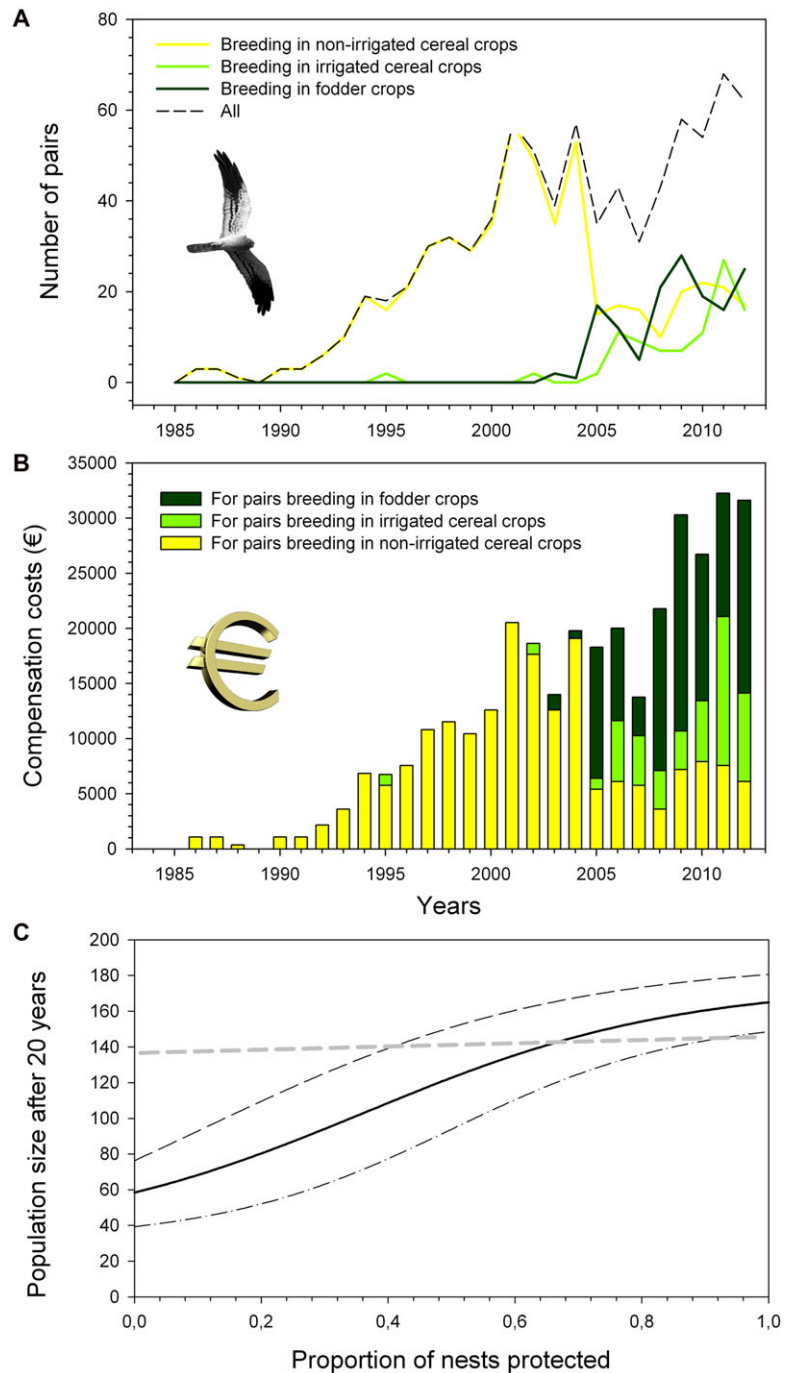
Our conceptual framework to characterize conservation strategies is based on the different factors included in the decision-making process for assessing the effectiveness of such strategies. Conservation measures can be categorized according to: (1) their effectiveness in reversing biodiversity trends, via short-term modifications of targeted species demographic parameters like productivity or survival, or community parameters, such as species richness; (2) the economic costs directly associated with their implementation; (3) the expected long-term need of maintaining that measure; and (4) the negative effects on species or communities if the measure is not maintained. Reactive and proactive conservation measures mostly differ along these criteria (Table 1), since reactive

approaches will often require long-term implementation of measures under an active threat, with strong negative effects on targeted species or communities if the implementation is interrupted. We define a conservation trap as a reactive, costly conservation strategy in which, even if management actions succeed in achieving biodiversity or demographic recovery goals, targeted communities or species suffer unduly when the adopted measures are interrupted, thus perpetuating the need for their implementation.

In human-dominated systems, such as European farmlands, several conservation strategies lay within reactive approaches based on financial incentives or active conservation management (Aebischer *et al.* 2000). They are usually variable in terms of economic costs, but positive effects are expected to be directly related to the budget invested and often result in positive effects on certain species, but not necessarily on overall diversity (Santana *et al.* 2014). The likelihood of maintaining current conservation strategies in the long-term is highly uncertain and intensely questioned (Jenkins *et al.* 2004; Fischer *et al.* 2012). However, the disappearance of these programs would likely entail a high risk for biodiversity maintenance and the viability of targeted species.

## Reactive conservation approaches for Montagu's harriers

The conservation of the Montagu's harrier in northeastern Spain offers a clear example on how the application of reactive approaches in farmlands could lead to conservation traps. The Montagu's harrier is a ground-nesting raptor that breeds mostly in croplands across Western Europe. It declined in many areas due to farmland intensification, which lead to decreases in habitat quality and food resources for the species, but also to an important increase in direct mortality of chicks through harvesting operations (Arroyo *et al.* 2003). Spain holds ca. 25% of the European population of the species excluding Russia. Conservation interventions to decrease nestling loss during harvest have been adopted since the late 20th century in Spain. Most of these have been based on reactive approaches aimed at increasing productivity rates through active management including the removal of the nestlings during harvesting operations and their relocation to the same or a safe place nearby, or the maintenance of a relatively small buffer zone of unharvested standing crop around the nest (Arroyo *et al.* 2003). In Lleida (NE Spain), initial attempts to protect nests with small, unharvested buffers proved to be inefficient due to predation of nests. Thus, the main conservation measure has been to negotiate with farmers a delayed mowing in an area of half hectare around the nest until



**Figure 1 The Montagu's harrier conservation trap.** Population trend for the breeding population of Montagu's harrier *Circus pygargus* in Lleida, NE Spain, showing the number of breeding pairs (A) and total compensation costs for delayed mowing (B) in different crop types. Panel (C) shows the estimated Lleida population size after 20 years (solid black line) depending on the proportion of protected nests (modified from Santangeli *et al.* 2014). The dashed horizontal line indicates population size at the beginning of the simulation period (current population size: 65 pairs, or 140 individuals assuming 10% nonbreeding). The upper and lower dashed lines represent projected population sizes assuming 80% and 85% or 75% and 80% adult male and female survival, respectively.

fledging, compensating farmers for the loss of crop value (Pomarol *et al.* 1995). In recent years, harriers have also begun to breed in irrigated fodder crops (Figure 1), particularly since 2005 when a strong drought occurred, which deemed dry cereal unsuitable for harrier nesting, and following the implementation of irrigation schemes at that time in nearby areas. These crops have higher

economic value (and thus higher compensation payments). Farmers are compensated ca. 360€ for delaying harvest of a half hectare of cereal, and up to 900€ for delaying harvest of a half hectare of fodder crops (Santangeli *et al.* 2014). The conservation measure has been effective from a demographic point of view, increasing harrier productivity and breeding population size through

recruitment (Figure 1A). However, overall nest protection costs have also increased, because there are more pairs to protect, occupying a more extensive area (implying greater costs associated with locating nests), and because they are increasingly breeding in crops with higher economic value (Figure 1B). This, in itself, challenges the viability of this strategy in the long-term, as population viability analyses suggest a need for continuous protection to maintain the Lleida population (Figure 1C), given that removal of the action would imply the removal of its positive effects. When we assessed the conservation strategy currently implemented for the Montagu's harrier in Lleida using the criteria introduced above, it fitted with our definition of a conservation trap: a highly effective reactive strategy associated with high (and increasing) economic costs derived from its implementation, a need for long-term maintenance and a strong negative impact if that measure was to disappear in the future (Table 1).

## Proactive conservation approaches as alternatives

Can alternatives to such a situation be identified? Under proactive approaches, the best strategy would be to modify the system in order to reach a self-sustainable state (Fischer *et al.* 2012). This implies a shift in conservation perspectives so that the emphasis is put on long-term effectiveness and sustainability (Table 1). Rather than focusing on mitigating the damage of human actions on the ecological subsystem, proactive approaches should focus on how to innovate and transform the whole system into new more desirable arrangements where the threat is not present.

Following with the example of the Montagu's harrier in Spain, some practical initiatives conducted in Catalonia for the conservation of the species can be used to illustrate how a change in conservation focus may lead to more sustainable results. In that area, an experimental alternative conservation program started in 1988 with the aim of modifying harrier breeding behavior, so they do not entirely depend on crop habitat for breeding (and thus on sustained protection from harvest), but on existing natural habitats, such as shrublands and meadows, unoccupied by the species at that time in that area. Under this program, birds reared in captivity were released in existing natural habitats by the method of "hacking" (Pomarol *et al.* 1995). The hacking site was an area with natural vegetation potentially suitable for harrier breeding, located in the Girona Province, ca. 190 km away from the farmland harrier breeding area. The purpose of that program was to favor the settlement of some of the released fledglings in that area, thus

creating a breeding population in natural vegetation, unaffected by harvesting. A few years later, a small breeding population settled in that area, but it never reached more than a few pairs (Arroyo *et al.* 2003), and this program was eventually stopped. However, shifting conservation efforts from protecting nests in farmland to increase this small population could lead to a situation where the population breeding in natural habitats (where the harvesting threat is not present) acts as a source to other connected areas or populations, and enhances long-term population viability even in the absence of direct and reactive conservation measures (Arroyo *et al.* 2002). This would need developing new measures, and a more accurate evaluation of long-term effectiveness of this strategy. In addition, potential alternative solutions should also be investigated. The key point we want to make here is how the change in the focus of conservation measures could lead to innovative approaches targeting transitions to new states not requiring (or at least minimizing) the reactive need of expensive conservation measures.

The false idea of success of narrowly focused approaches (i.e., short-term biodiversity or demographic recovery goals) could prevent managers from testing or adopting alternative practices. However, early evidence suggests that proactive approaches may provide valuable solutions to improve long-term biodiversity conservation. In this regard, Fischer *et al.* (2012) showed that conservation strategies focused on supporting community-led efforts to create new, direct links with nature (e.g., develop markets for organic products or regional specialty products, or develop an eco-tourism industry), could promote the integration of environmental values as a fundamental part of their cultures and management processes (allowing biodiversity conservation even in the absence of conservation actions). In a similar way, it is increasingly recognized that conservation actions focused on education and the promotion of social norms and identities leading to management practices that are sustainable both in ecological and socioeconomic terms (Fischer *et al.* 2012; De Snoo *et al.* 2013) could also eventually provide long-term efficient solutions (Pretty 2003).

## In search for new instruments

It is widely recognized that a key challenge for conservation in human-dominated landscapes is to find instruments that are not only able to temporarily revert the negative effects of management threats, but that will make durable changes likely. However, the false certainty about the long-term efficacy of reactive approaches and their blindness to the future can result, in some situations, in costly conservation traps. Taking into



account that many conservation strategies in agricultural landscapes have been based on reactive approaches, the example described in this article is not likely to be an exceptional case. Additionally, recent evidence suggests that similar situations may be occurring in other systems, and thus the problem might be broader. For example, Scott *et al.* (2010) demonstrated that 84% of species listed under the United States Endangered Species Act will require continued species-specific interventions to ensure their viability; and Redford *et al.* (2011) concluded that a large proportion of threatened vertebrates worldwide would not be viable if current conservation interventions are not sustained in the long term.

Moving toward approximations that look more into the future, scanning, and forecasting potential alternative solutions and their implications on the long-term, may provide a new perspective to improve our capability to avoid costly conservation traps (Sutherland & Woodroof 2009; Cardador *et al.* 2014; Cook *et al.* 2014). This would help identifying opportunities for creating transitions from present situations threatening biodiversity, to new nonthreatening states. A key challenge of such approaches would be developing interdisciplinary knowledge, so that assumptions of different groups can be discussed and their potential consequences evaluated. Indeed, it is of paramount importance that new conservation approaches are designed in light of the socioeconomic reality of the system in which they have to be applied in order to ensure their long-term effectiveness (Fischer *et al.* 2012; De Snoo *et al.* 2013). This is particularly relevant as there are opportunity costs to all conservation investments, thus a conservation trap would lead to lost opportunities of using resources in other areas, species, or communities. Avoidance of conservation traps might clearly benefit from evidence-based approaches, where the consequences of decisions and conservation actions applied are routinely and systematically reviewed and documented (Sutherland *et al.* 2004b).

Reactive conservation measures have a role in conservation policies because some issues occur suddenly and unexpectedly and they provide favorable contexts to rescue communities or populations in the short term. However, relying solely on them is unlikely to provide a sustainable way of enhancing biodiversity and landscape quality in the long term. We stress the need to invest a substantial part of available conservation resources to proactively scan and develop holistic strategies to avoid and if possibly prevent costly and inefficient conservation traps. Taking into account that many biodiversity challenges are the result of technical developments, land-use transformations or new legislations with predictable impacts on biodiversity, proactive approaches

can be used not only to guide ongoing management, but also to predict site suitability and propose alternative solutions in advance to new threats. In this regard, it will be important in the future to link socioeconomic and environmental policies so that neither is compromised by the other. This is particularly important in all cases where sharing nature conservation and commodity production on the same land is the dominant strategy, as in European farmlands. Recent methodological advances, such as scenario building, mental models, or optimization analyses, may provide valuable tools for such purposes (Cook *et al.* 2014; Ewen *et al.* 2014). Additionally, when looking for alternative solutions, more attention should be devoted to the mismatch in temporal scales between the long-term requirements of environmental management and the short time horizons governing public and private decisions affecting the environment (Hartig & Drechsler 2008).

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## Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

### Appendix S1

**Table S1.** Examples of reactive conservation measures.

This material is available as part of the online article from: <http://www.blackwell-synergy.com/doi/full/10.1111/j.1755-263X.2008.00002.x>

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